

amplifier output power 226 will first go down, and then will go back to its original setpoint value of 16 dBm (40 mW). In this case the transition time is close to 0.5 mseconds.

5 The exemplary amplifier 100 of the present invention has a controller 120 with a capability of output power and gain transient suppression and temperature control of the laser pump diode. Control requirements, such as set point and control mode are remotely sent to the amplifier 100 via standard interface (serial, parallel or Ethernet). Monitoring signal and alarms from the amplifier are received by using the same interface. Two embedded processors allow high level of flexibility in the choice of
10 control and processing algorithms. The technique of signal compression and dynamic range switching makes this device suitable for use in systems with very wide dynamic range of signals. This particular amplifier 100 utilizes two independently controlled pump lasers. The second pump is used to boost the signal power. The controller 120 may also utilize more sophisticated control algorithms, which can cope with some long-
15 term effects, such as parameter changes caused by the optical component aging.

Accordingly, it will be apparent to those skilled in the art that various modifications and adaptations can be made to the present invention without departing from the spirit and scope of the invention. For example, the controller 120 can be utilized with non-erbium- doped fiber amplifiers, for example, Tm-doped amplifiers. It
20 may also be utilized in amplification systems that include Raman amplifiers, or planar waveguide amplifiers. It is intended that the present invention covers the modifications and adaptations of this invention as defined by the appended claims and their equivalents.

What is claimed is

1. An amplifier characterized by gain and output power comprising:
 - (i) at least one gain medium;
 - 5 (ii) at least one pump supplying optical power into said gain medium;
 - (iii) a controller controlling said gain and said output power of said amplifier, said controller including a signal compression circuit to cover a wide dynamic range for optical input and output signals, so that resolution for low optical signals is better than resolution for high optical signals.
- 10 2. The amplifier according to claim 1, wherein said gain medium includes at least one coil of rare earth doped fiber.
3. The amplifier of claim 1, wherein said controller utilizes a logarithmic circuit.
- 15 4. The amplifier of claim 1, wherein said controller electronic gain switch circuit.
5. The amplifier of claim 2, wherein said controller utilizes a logarithmic circuit.
- 20 6. The amplifier of claim 2, wherein said controller electronic gain switch circuit.
7. The amplifier of claim 1, wherein said controller utilizes at least two feedback loops, one of said loops being a fast loop and another one of said feedback loops being a slow loop, wherein said slow loop operates in the range of 1 Hz to 10 kHz, and said fast loop operates in the range of 500KHz to 10Mhz.
- 25 8. The amplifier of claim 7, wherein said fast loop is pump power control loop, and said slow loop is pump temperature control loop.
- 30 9. The amplifier of claim 8, said slow loop is also temperature control loop of rare-earth doped fiber.

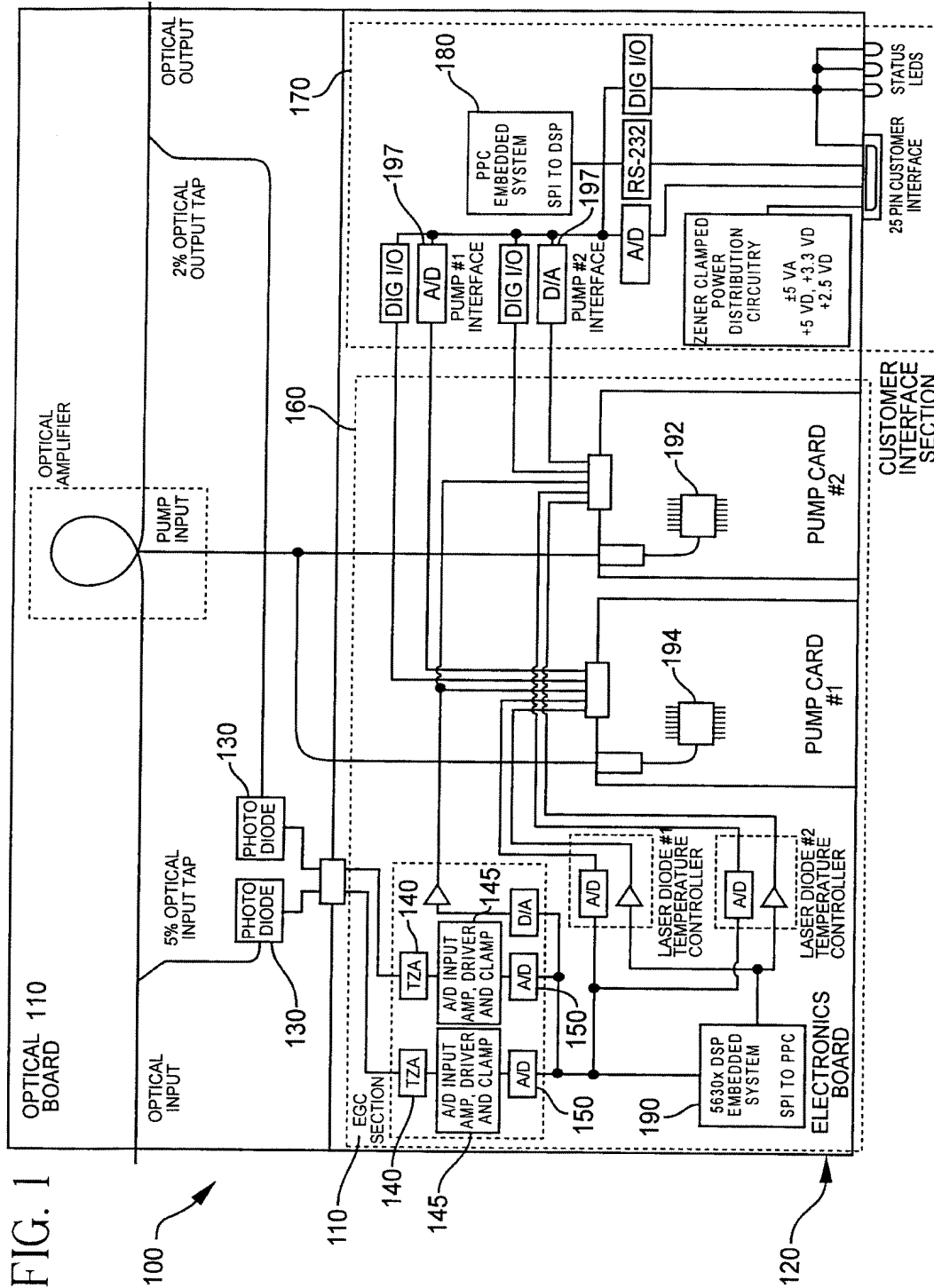
10. The amplifier of claim 1, wherein said controller utilizes only a slow control loop, said slow control operating in the range of 1-1000 Hz, and does not control power transients.
- 5 11. An amplifier characterized by gain and output power comprising:
(i) gain medium including rare earth-doped fiber;
(ii) a pump supplying optical power into said gain medium;
(iii) a controller controlling said gain and said output power of said amplifier,
said controller including an electronic gain switch to cover a wide dynamic
10 range for optical input and output signals, so that resolution for low optical signals is better than resolution for high optical signals.
12. The amplifier of claim 11, wherein said controller includes (i) an A/D converter, and (ii) an electronic gain switch, said electronic gain switch detects the level of
15 electrical signal corresponding to optical signal level and, when said electrical signal is lower than a predetermined amount, and multiplies that signal by a predetermined constant, providing this multiplied signal to A/D converter.
13. The amplifier of claim 11, wherein said controller includes (i) an A/D converter,
20 and (ii) an electronic gain switch, said gain switch said electronic gain switch detects the level of electrical signal corresponding to optical signal level and, when said electrical signal is higher than a predetermined amount for a predetermined period of time, and lowers the electronic gain, provided by the electronic gain switch, so that the input to the A/D converter stays within its range, thereby
25 preventing an overflow condition.
14. An amplifier according to claims 2, 4 and 13, wherein said electronic gain switch includes a circuit that utilizes hysteresis to prevent unwanted electronic gain switch oscillation.
- 30 15. The amplifier of claim 1, furthers comprising A/D converter that can convert multiple analog signals simultaneously into multiple digital signals.

16. The amplifier of claim 15, wherein one of said analog signals corresponds to optical input power and the other one of said analog signals corresponds to the optical output power.

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17. The amplifier of claim 1, wherein said controller incorporates an automatic gain control, coil temperature and pump temperature control system and a communication/alarm processing system.

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FIG. 2

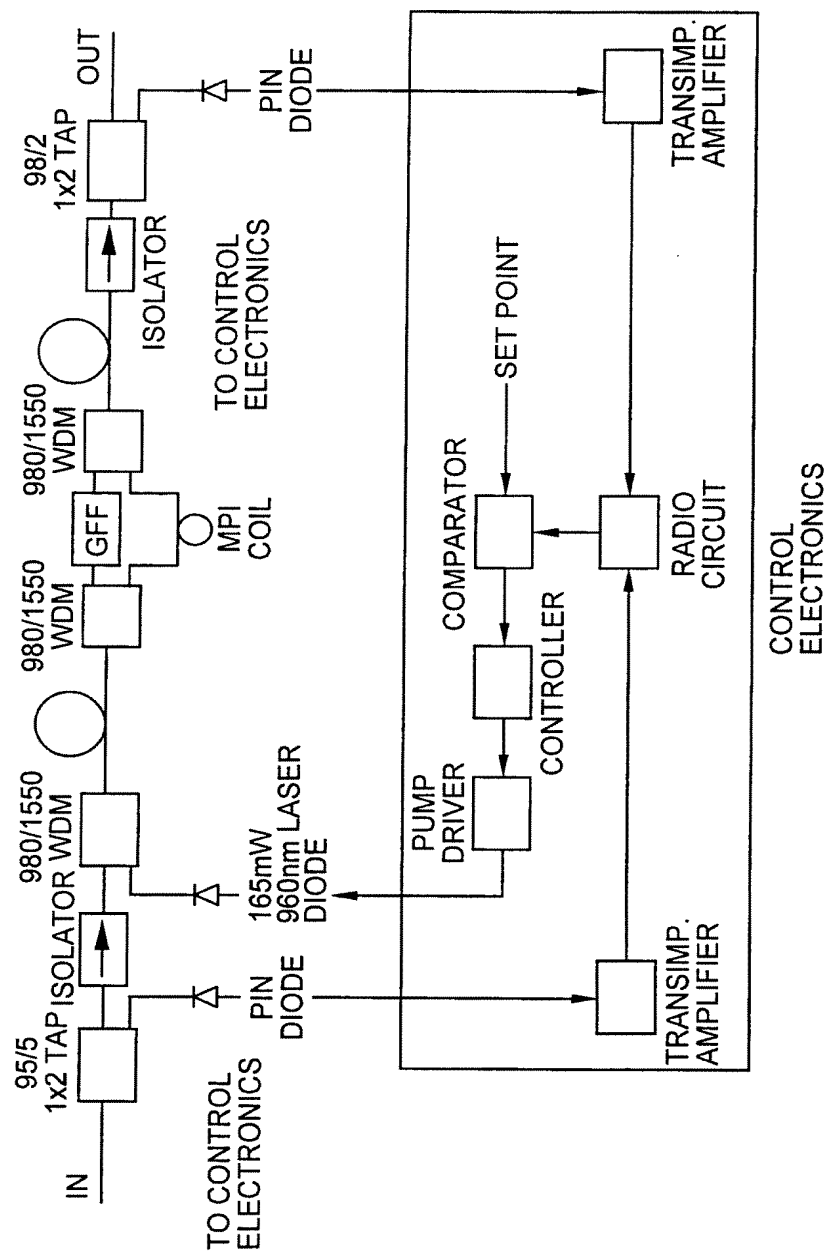
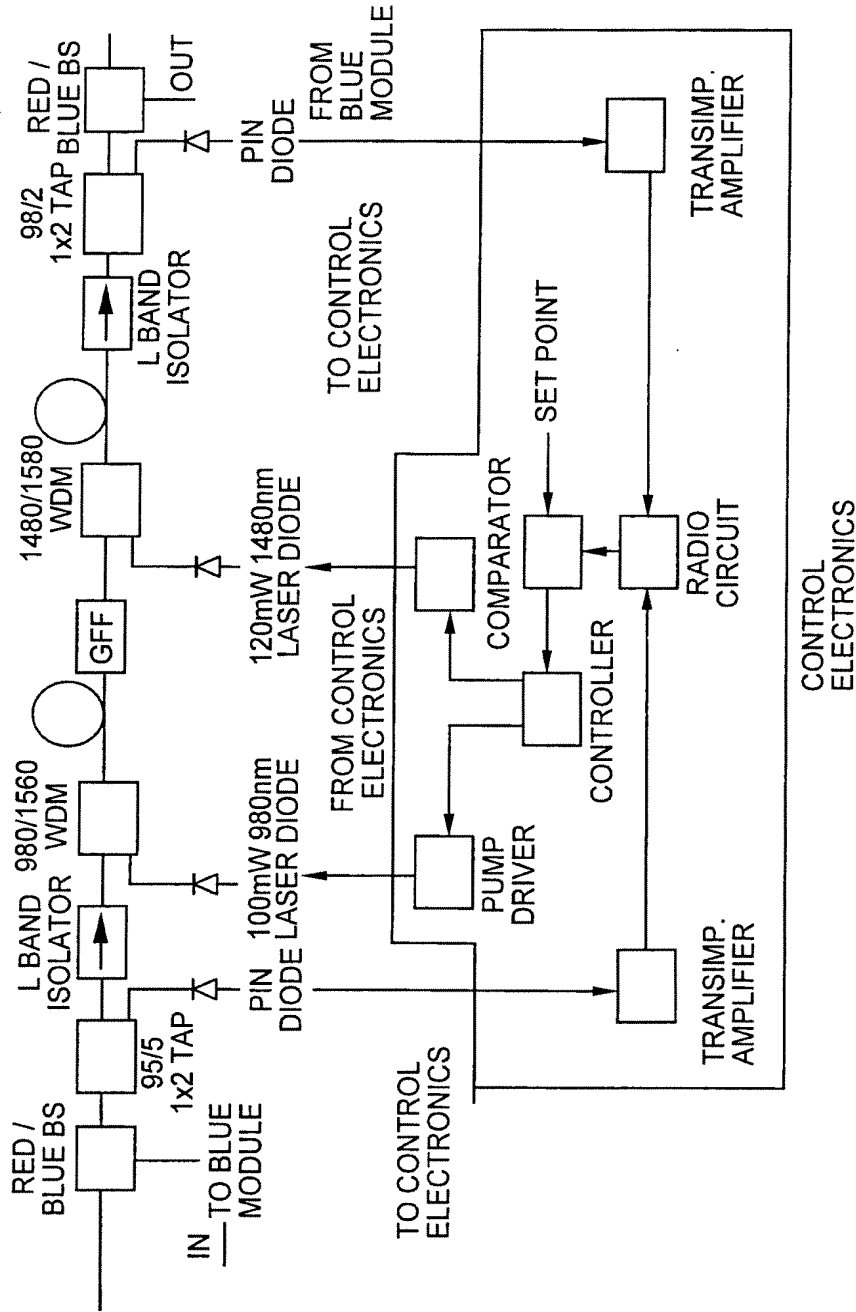


FIG. 3



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FIG. 4A

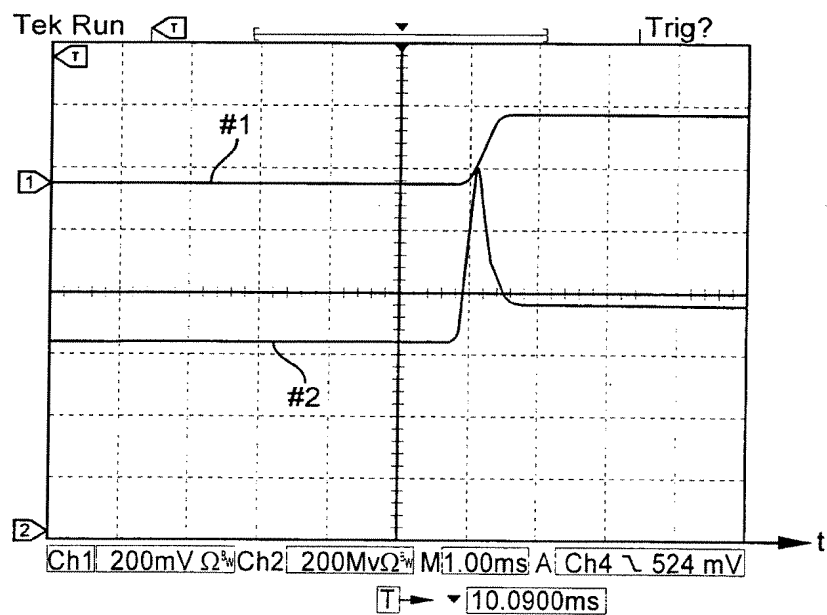
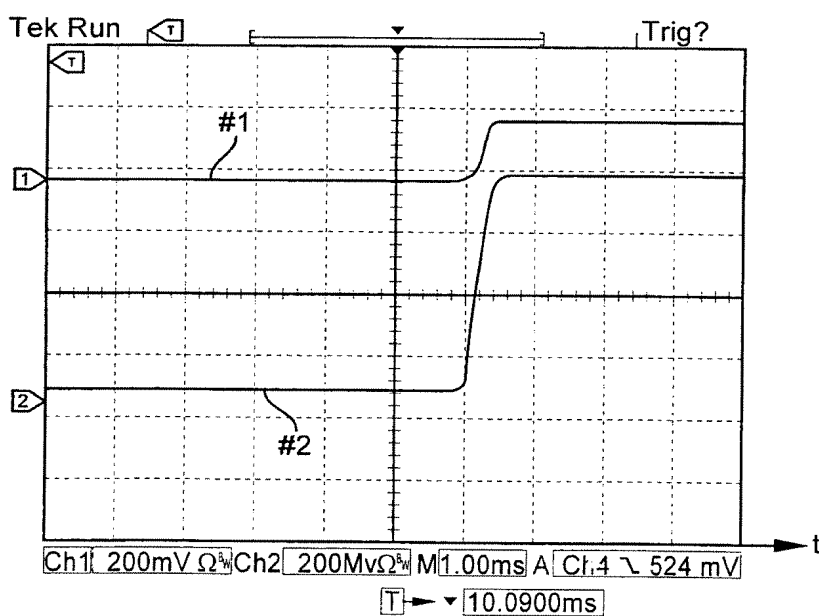


FIG. 4B



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FIG. 4C

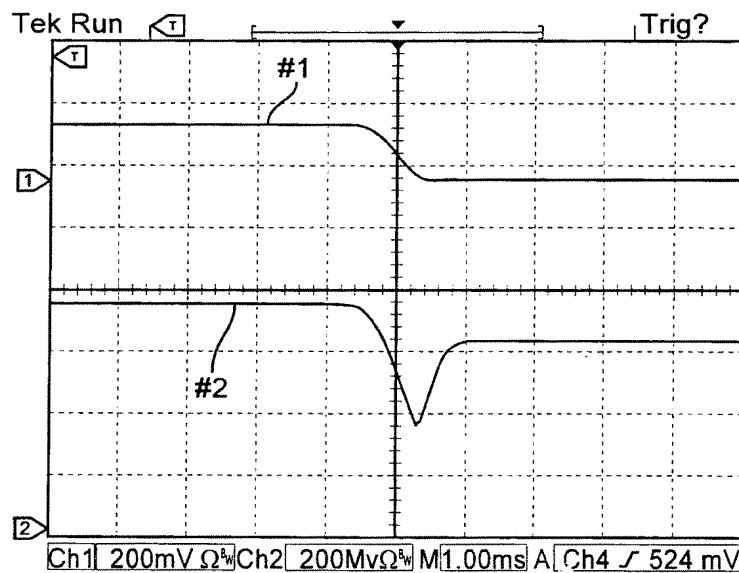
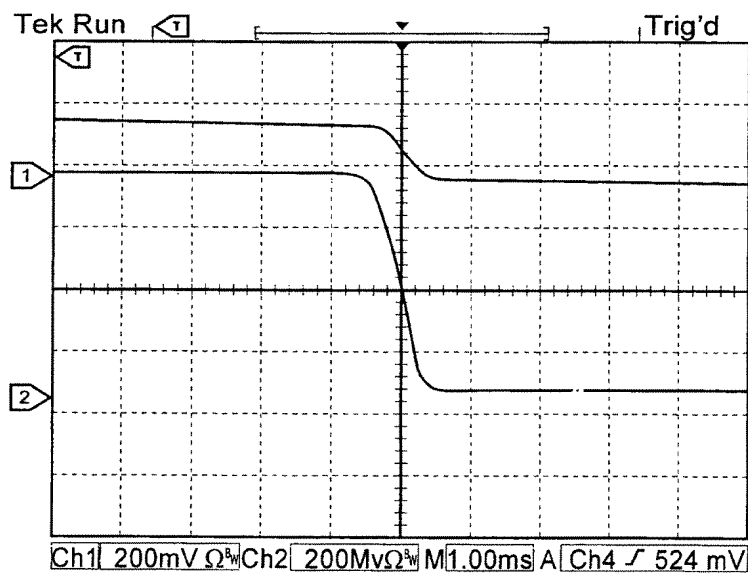


FIG. 4D



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FIG. 5A

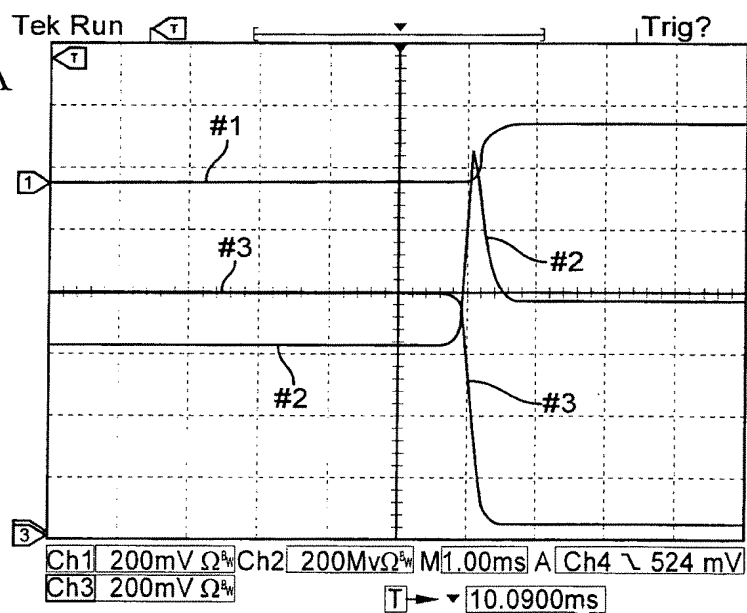
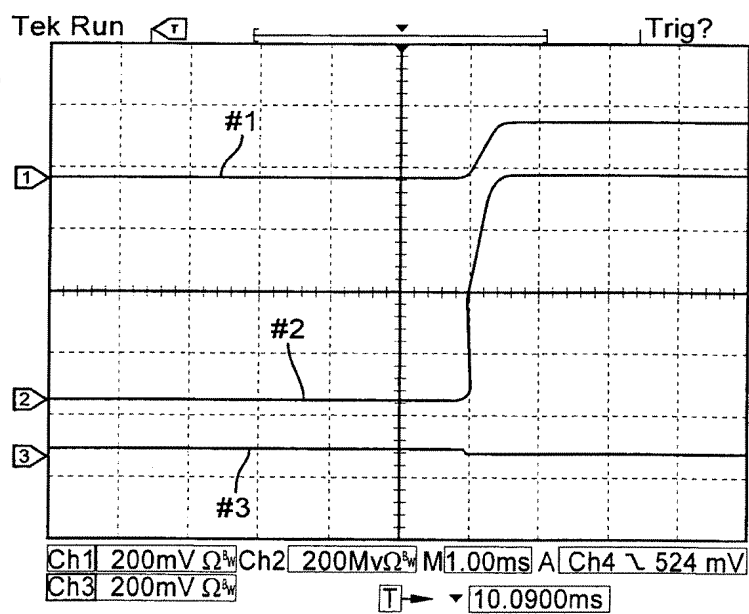


FIG. 5B



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FIG. 5C

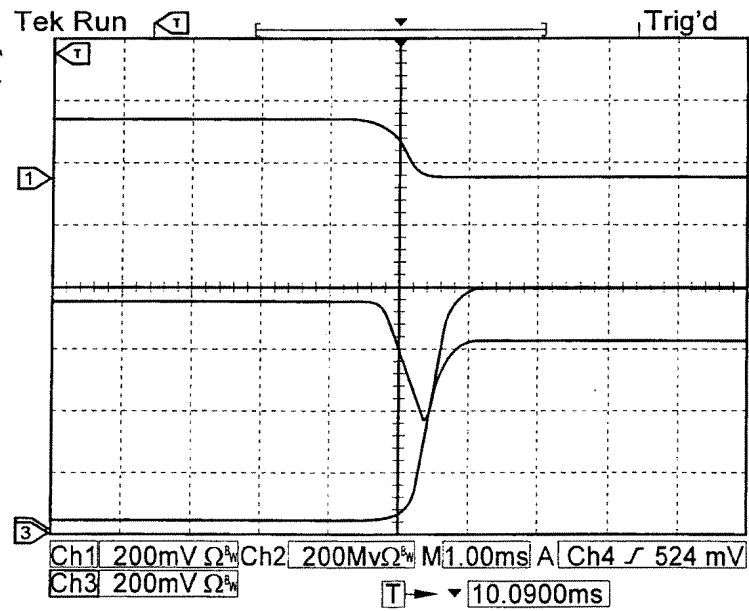
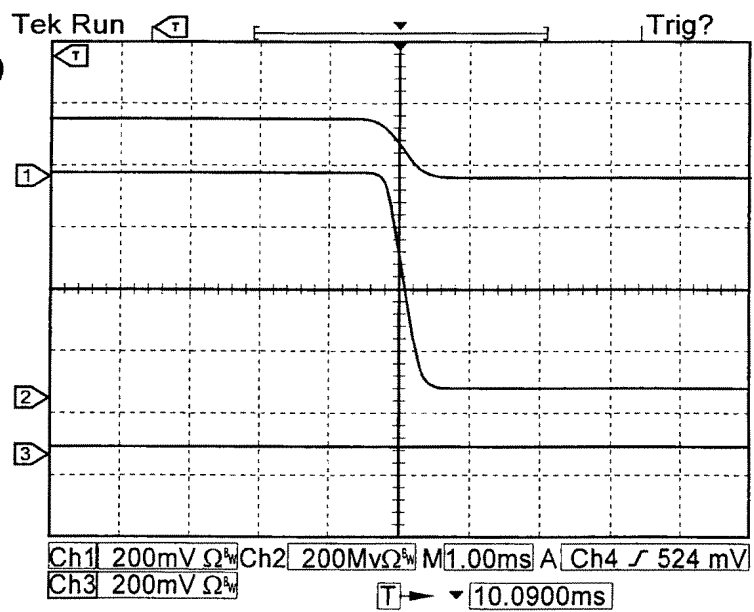
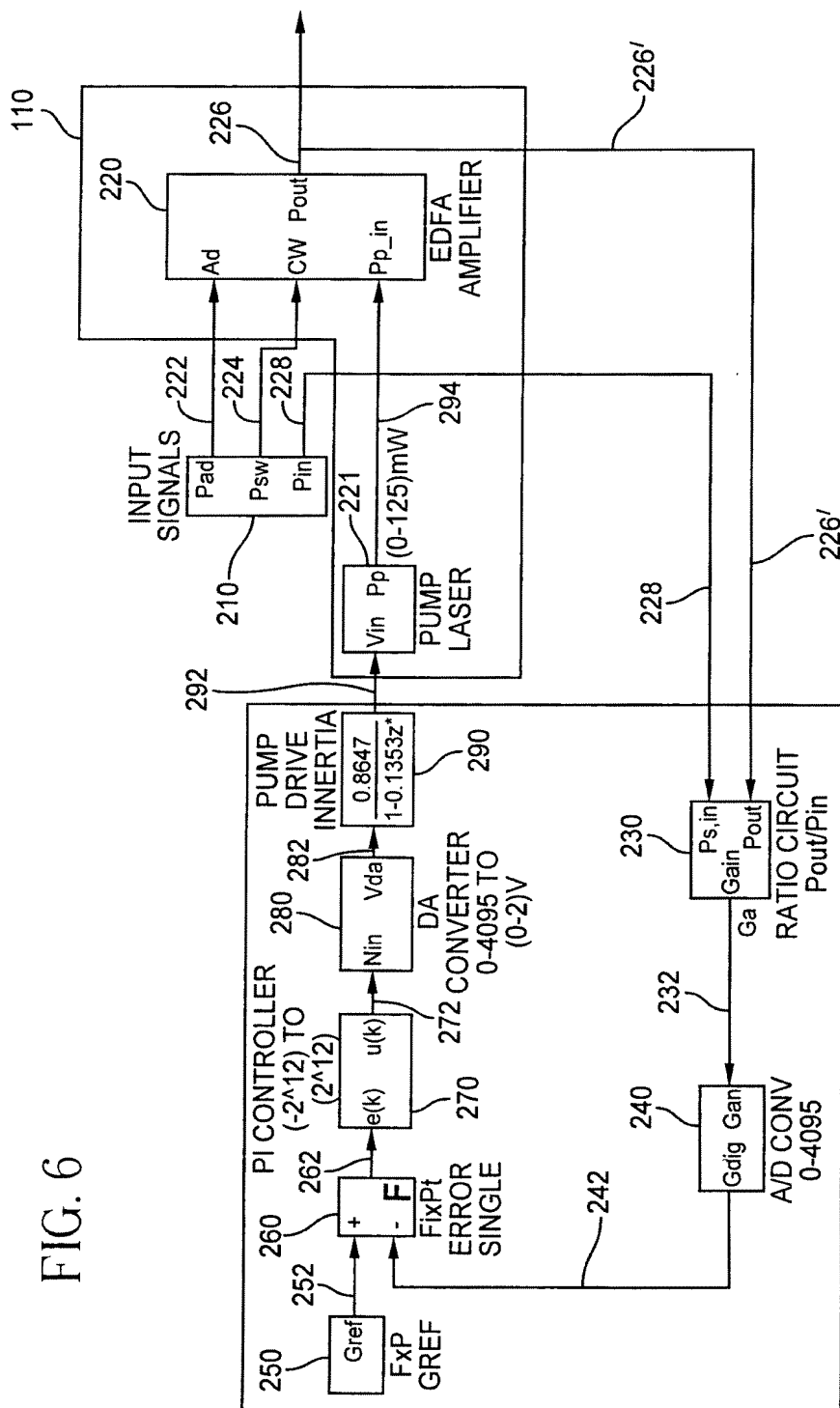


FIG. 5D



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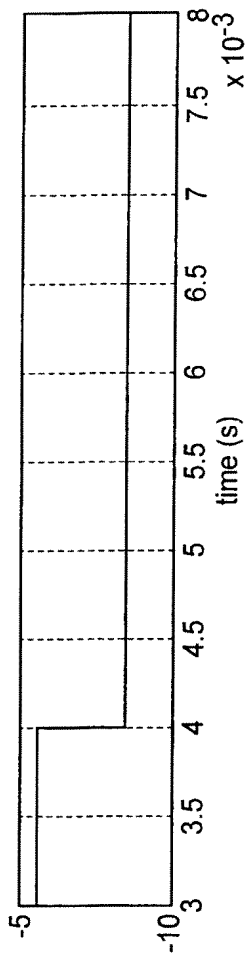


FIG. 7A

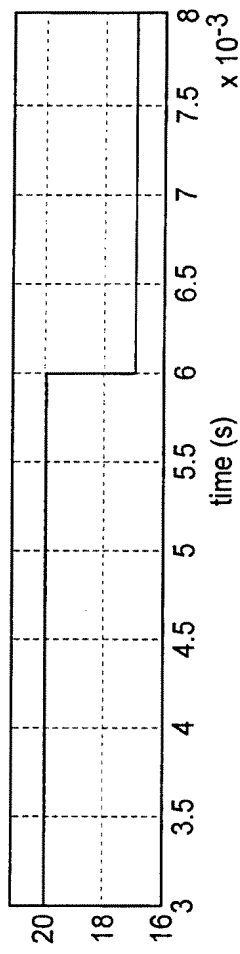


FIG. 7B

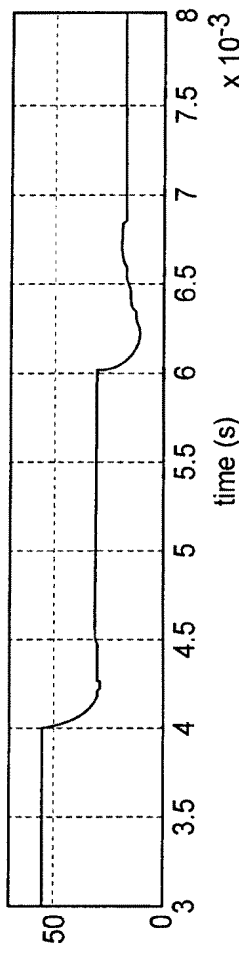


FIG. 7C

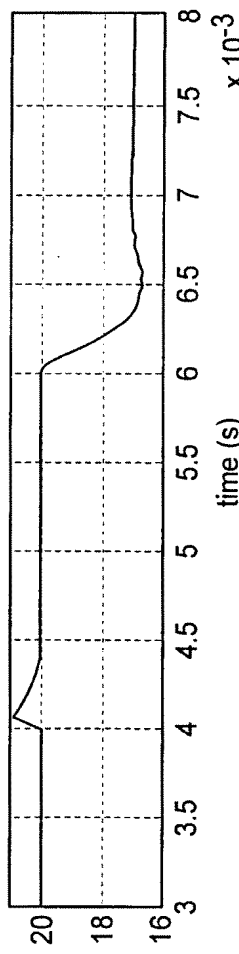
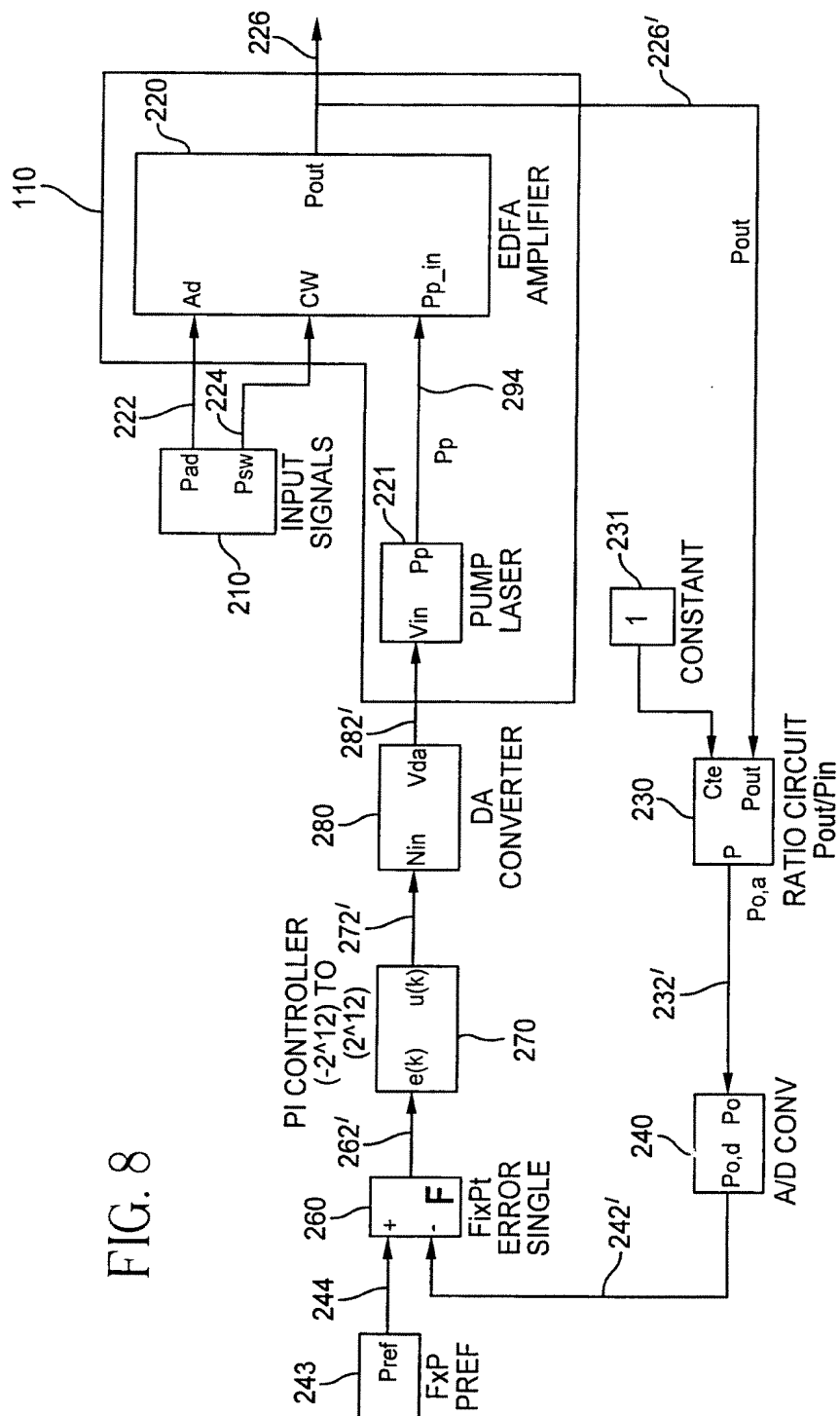


FIG. 7D

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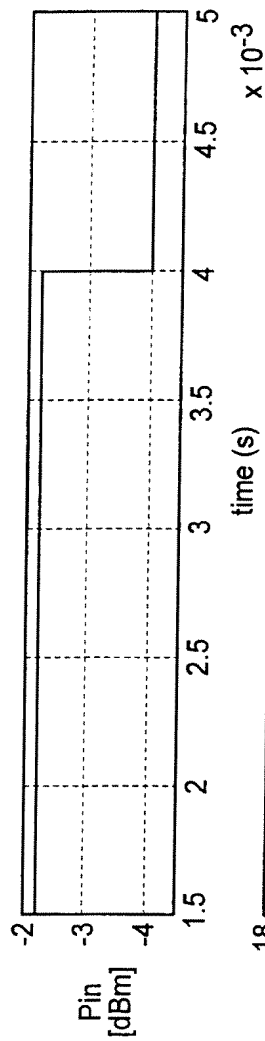


FIG. 9A

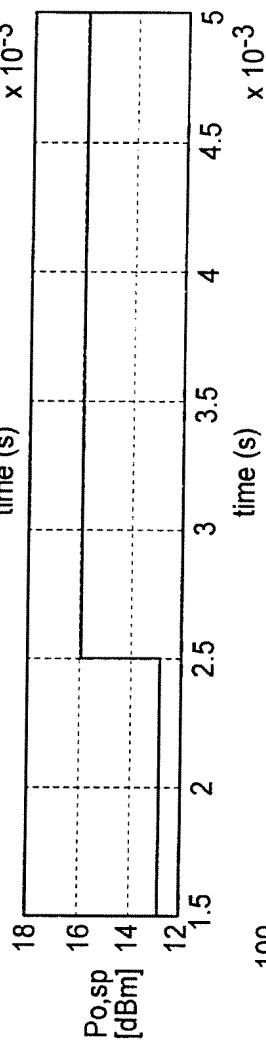


FIG. 9B

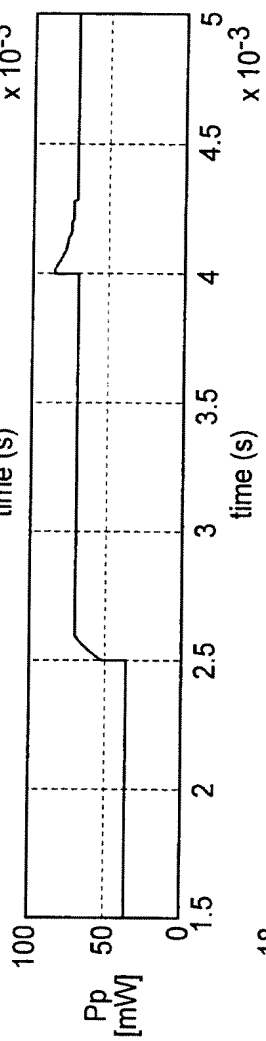


FIG. 9C

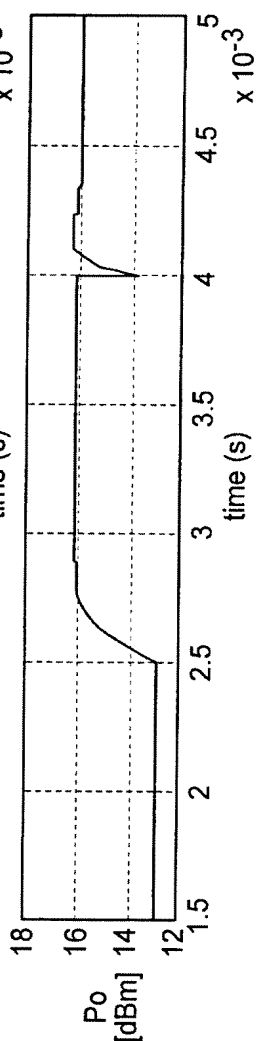


FIG. 9D

INTERNATIONAL SEARCH REPORT

International application No.

PCT/US01/06026

A. CLASSIFICATION OF SUBJECT MATTER

IPC(7) : H01S 3/00
US CL : 359/341.3, 341.4, 341.41

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
U.S. : 359/341.3, 341.4, 341.41

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	US 5,923,462 A (VAN DER PLAATS) 13 July 1999, Figure 1	1-17
Y	US 5,703,711 A (HAMADA) 30 December 1997, Figure 1	1-17
Y	US 5,363,385 A (HEIDEMANN) 08 November 1994, Figures 1 and 2.	8, 9 and 17

☐ Further documents are listed in the continuation of Box C.

☐ See patent family annex.

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"O" document referring to an oral disclosure, use, exhibition or other means	"&" document member of the same patent family
"P" document published prior to the international filing date but later than the priority date claimed	

Date of the actual completion of the international search

16 August 2001 (16.08.2001)

Date of mailing of the international search report

10 OCT 2001

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